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# Organic Carbon, Total

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For water and wastewater

Direct Method

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## Introduction

Total Organic Carbon (TOC) testing is important in drinking water treatment as an indicator of potential disinfection by-product formation. In wastewater, TOC is valuable as a surrogate for COD testing and has applications in domestic wastewater pre-treatment standards, effluent discharge limitations, and industrial process waters.

The colorimetric TOC test measures the total amount of non-volatile organic carbon in a sample. The method is based on controlled digestion/diffusion in a sealed glass assembly\*. Sample carbon is oxidized to carbon dioxide by persulfate oxidation. The carbon dioxide diffuses into a colored pH indicator solution where it is converted into carbonic acid. The resulting color change is proportional to the concentration of carbon present in the sample.

## Chemical reactions

Inorganic carbon is removed from the sample by adjusting the sample to pH 2 with a buffer, and stirring vigorously for 10 minutes:

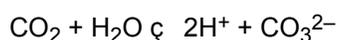
$$\text{TOC} = \text{Total Carbon} - \text{Inorganic Carbon}$$

A suitable volume of treated sample and potassium persulfate is added to a 16-mm screw top digestion vial containing Acid Digestion Solution Reagent. A 9-mm sealed glass ampule containing the TOC Indicator Solution is opened and placed inside the digestion vial. The whole assembly is then sealed with a screw cap and digested at 103–105°C (217–221 °F) for 2 hours.

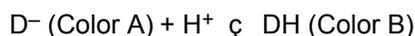
In the presence of acidic persulfate and with increased pressure and elevated temperature, the sample's organic carbon is oxidized to carbon dioxide. For example, in the persulfate digestion of a sample that contains formate, the chemical reaction is:



The evolved CO<sub>2</sub> then diffuses and is trapped in an aqueous solution containing a pH indicator. The absorbed CO<sub>2</sub> forms carbonic acid according to:



The pH indicator (prior to CO<sub>2</sub> absorption) is in its deprotonated, or basic, form (D<sup>-</sup>). As the absorbed CO<sub>2</sub> level increases, the hydrogen ion level will also increase, resulting in an increase of the protonated form of the indicator:



The concentration of the carbon in the sample is proportional to the color change, either the change in Color A (DD<sup>-</sup>), or the change Color B (DDH) or the sum (DD<sup>-</sup> + DDH).

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\* U.S. Patent 6,368,870